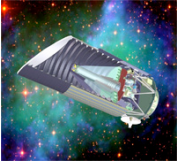


# Concept for a JDEM Science Operations Center

Erik Gottschalk  
Fermilab



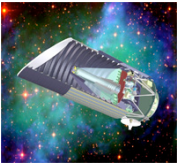
# Introduction

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We developed a conceptual design for SNAP Science Operations that is applicable to JDEM. As planning for JDEM evolves we will continue to adapt our design to meet the requirements for a JDEM Science Operations Center.

## Overview:

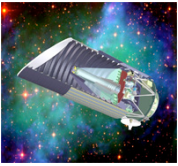
- What is a Science Operations Center?
- Requirements for Science Operations
- Science Operations Center (systems view)
- Software infrastructure (deployments)
  - Analysis and Development Facility (ADF)
  - Science Operations Center (SOC)
  - Laptop Deployment (LAP)
- Work Breakdown Structure (WBS)
- Conclusion



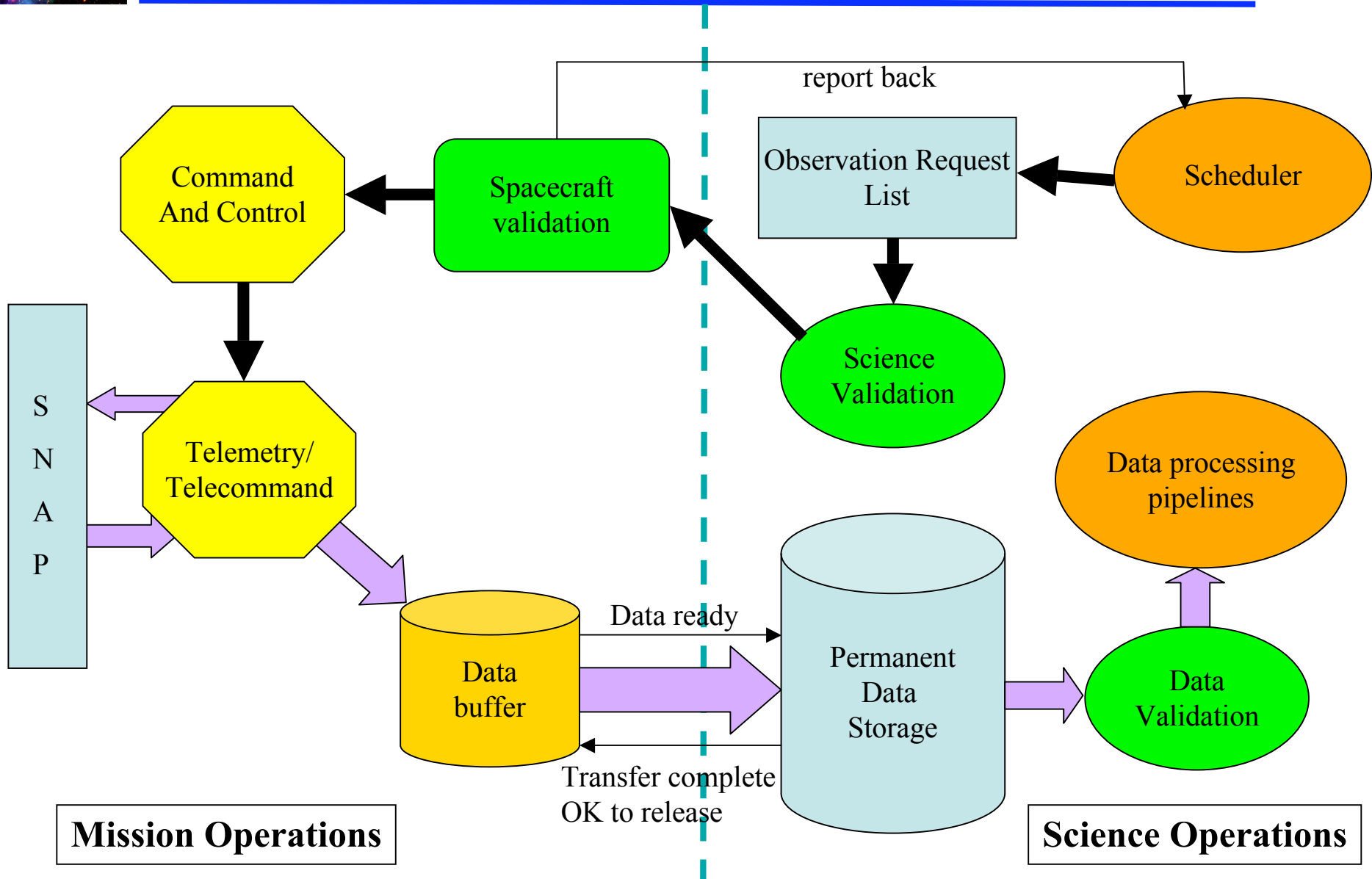
## What is a Science Operations Center?

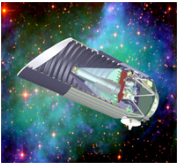
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- Provides computing, networking, and data management infrastructure for data processing pipelines, software development, and quality assurance (QA).
- Provides QA data analysis capabilities for scientists and engineers developing instruments for the mission.
- Interfaces with the Mission Operations Center (MOC); receives science and engineering data and generates observation requests (**supernova trigger**).
- Provides remote access to data and monitoring information, which is especially important during commissioning.
- Prepares science data products for collaborators doing science analyses and for the public archive.
- Provides a center for data operations with computing support for collaborators.



## MOC/SOC Interface for SNAP

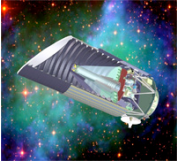




## Software Workshops and Site Visits

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- We held three workshops to develop requirements and then used these requirements to develop a conceptual design for SNAP Science Operations.
  - Science Operations Requirements Workshop at FNAL (July 23-25, 2008)
  - Science Operations Requirements Review at LBNL (August 21-22, 2008)
  - Software Design Workshop at LBNL (August 25-26, 2008)
- We extracted requirements from scenarios (e.g. daily data processing, science scheduling, etc.) that were developed during the first workshop at Fermilab.
- We completed the first version of the requirements document in September.
  - There are 18 subsections and 105 requirements in this document.
  - The requirements are fairly general, i.e. not specific to SNAP.
  - Requirements for the interface to a NASA Mission Operations Center (MOC) were not fully developed since we did not have necessary information in August.
  - Since then we have visited the Fermi ISOC, six MOCs (Fermi, ACE, RXTE, WMAP, EO-1, SDO), RXTE Science Ops Facility, and HST Alternate Ops Area.
  - We have met with a Network Systems Engineer at GSFC to discuss networking.
  - We have a meeting tomorrow (Nov. 5) at JPL with a NASA Telecommunications and Mission Systems Manager.



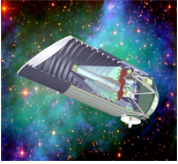
# Science Operations Requirements

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## Requirements categories:

- Computing Services
- Production Running
- Supernova Triggering
- Calibration
- Reprocessing
- Control and Monitoring
- Data Monitoring
- Scheduling
- Resources for End-User Analyses
- Storage and Retrieval of Collected and Derived Data
- Support for Science Commissioning
- Collaborative Operations and Analysis Tools
- Release Management
- Development Management
- Execution Management
- Environment, Safety and Health
- Security
- Public Data Release

The requirements review at LBNL in August called out the need to define the interface between Science Operations and Science Analyses.

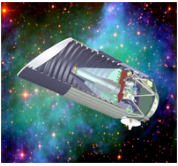


# Science Operations Deployments

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We have developed a conceptual design for Science Operations that involves **three deployments**. Each deployment provides **software infrastructure** to support the mission.

- **Analysis and Development Facility (ADF)**
  - Core software infrastructure for SOC (and Science Analysis Centers?)
  - Instrument QA
  - Software development platform
  - Workflow integration and testing
- **Science Operations Center Software (SOCS)**
  - Production workflow system (data processing pipelines)
  - Custodial data storage and central data management
  - Resource scheduling and science scheduling
  - Data import and export
  - DSN/MOC/SOC integration
- **Laptop Deployment (LAP)**
  - Enables software development, testing, QA and science analyses without a network connection

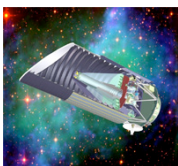


## Glossary

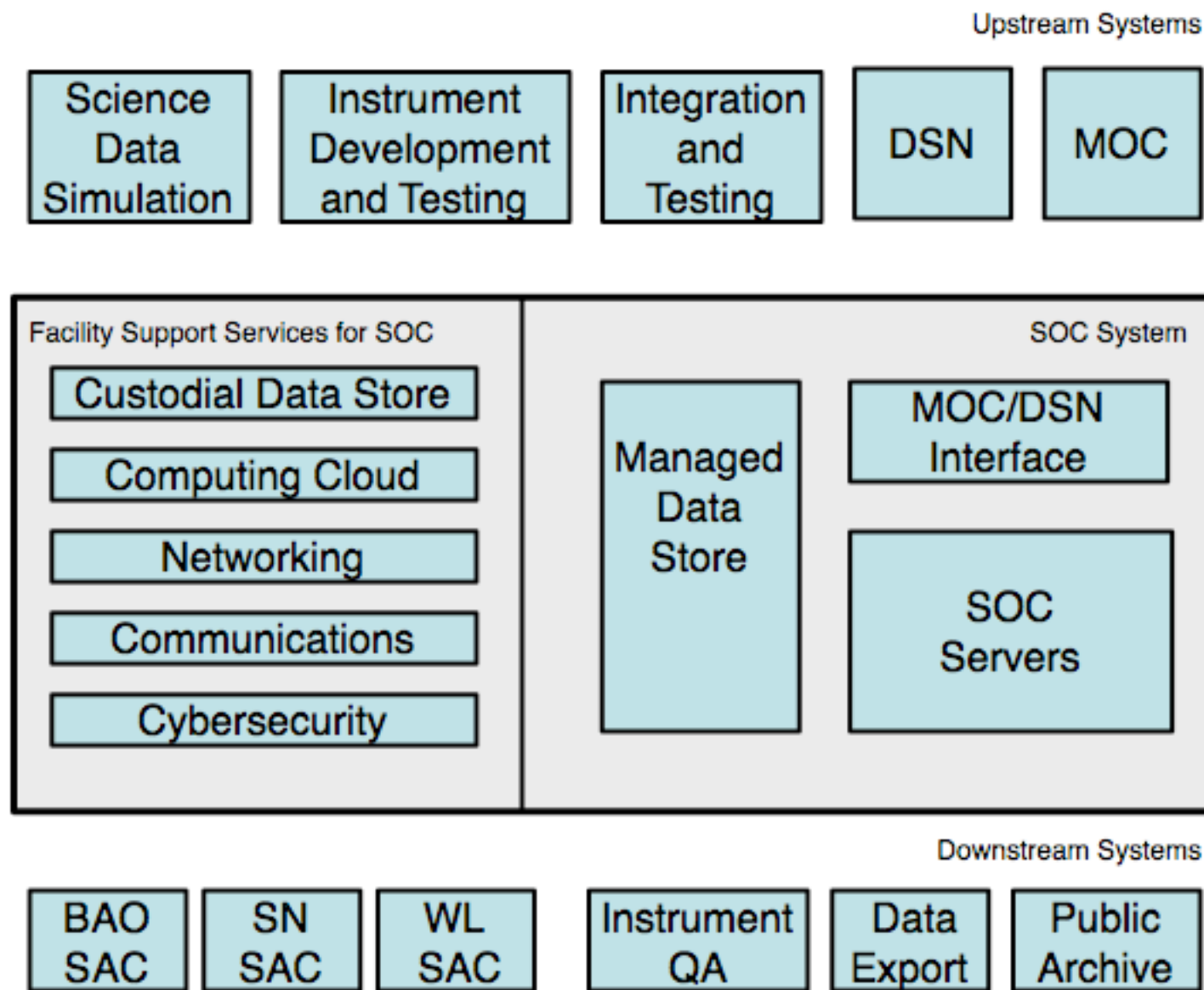
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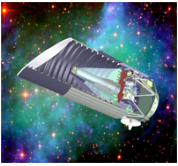
- ADF - Analysis & Development Facility
- BAO - Baryon Acoustic Oscillations
- ITAR - International Traffic in Arms Regulations
- DRF - Data Reduction Framework
- DRM - Data Reduction Module
- DSN - Deep Space Network
- LEO - Launch and Early Orbit
- MOC - Mission Operations Center
- ORL - Observation Request List
- QAF - Quality Assurance Framework
- QAM - Quality Assurance Module
- SAC - Science Analysis Center
- SOC - Science Operations Center
- SN - Supernova
- WL - Weak Lensing





## High-Level SOC Systems and External Systems





# Software Systems

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## Data Reduction System

- Data Reduction Framework (DRF)
- Data Reduction Modules (DRM)
- Data Reduction Framework Sensors

## Quality Assurance System

- Quality Assurance Framework (QAF)
- Quality Assurance Modules (QAM)
- Data Quality Monitoring (DQM)
- Mission Quality Monitoring (MQM)

## Online System

- Production System (PS)
- Calibration Creation (CC)
- Supernova Trigger (ST)
- Observatory Scheduler (OS)
- MOC/DSN Interface Manager

## Software Development

- Code and Release Manager (CODE)
- Development System (DEV)

## Data Management System

- Data Manager/Central (DM/C)
- Data Manager/Local (DM/L)
- SOC Proxy/Server
- SOC Proxy/Client

## User Interfaces

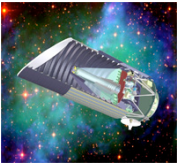
- Configuration Management (CONF)
- Global Resource Scheduler (GRS)
- SOC Manager (SOCM)
- Operations Display (OD)
- Remote Operations Display (ROD)

## External Data Systems

- External Data Ingest Manager (EDIM)
- Data Exporter (DE)
- Public Archive Interface (PAI)

## Integration and Test System

- Pipeline Integration Tester (PIT)



## Software Systems (ADF-specific subsystems in green)

---

### Data Reduction System

- **Data Reduction Framework (DRF)**
- **Data Reduction Modules (DRM)**
- **Data Reduction Framework Sensors**

### Quality Assurance System

- **Quality Assurance Framework (QAF)**
- **Quality Assurance Modules (QAM)**
- **Data Quality Monitoring (DQM)**
- **Mission Quality Monitoring (MQM)**

### Online System

- Production System (PS)
- Calibration Creation (CC)
- Supernova Trigger (ST)
- Observatory Scheduler (OS)
- MOC/DSN Interface Manager

### Software Development

- **Code and Release Manager (CODE)**
- **Development System (DEV)**

### Data Management System

- Data Manager/Central (DM/C)
- **Data Manager/Local (DM/L)**
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### User Interfaces

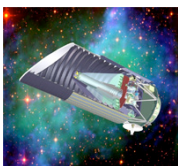
- **Configuration Management (CONF)**
- Global Resource Scheduler (GRS)
- SOC Manager (SOCM)
- **Operations Display (OD)**
- **Remote Operations Display (ROD)**

### External Data Systems

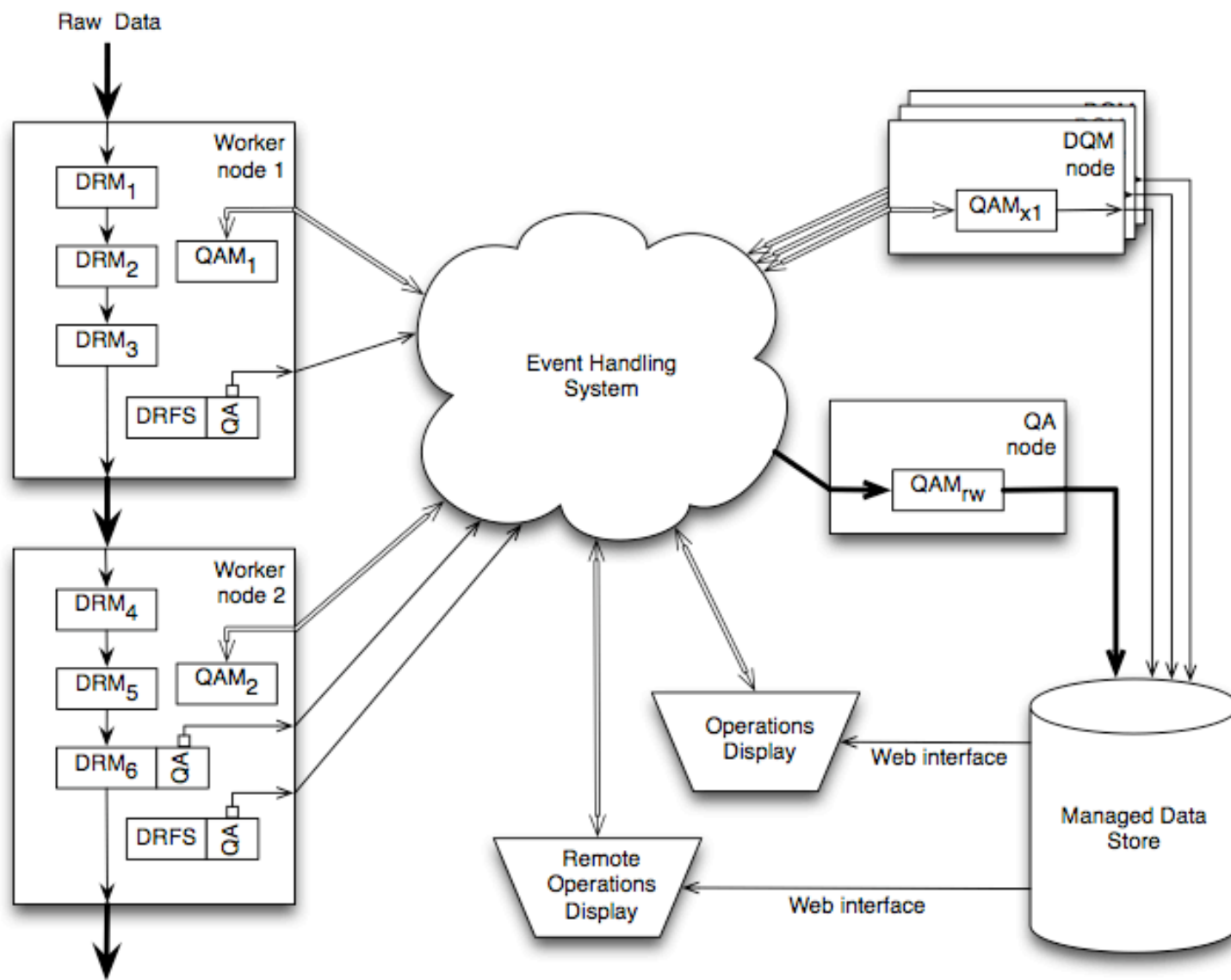
- **External Data Ingest Manager (EDIM)**
- **Data Exporter (DE)**
- Public Archive Interface (PAI)

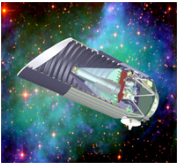
### Integration and Test System

- **Pipeline Integration Tester (PIT)**

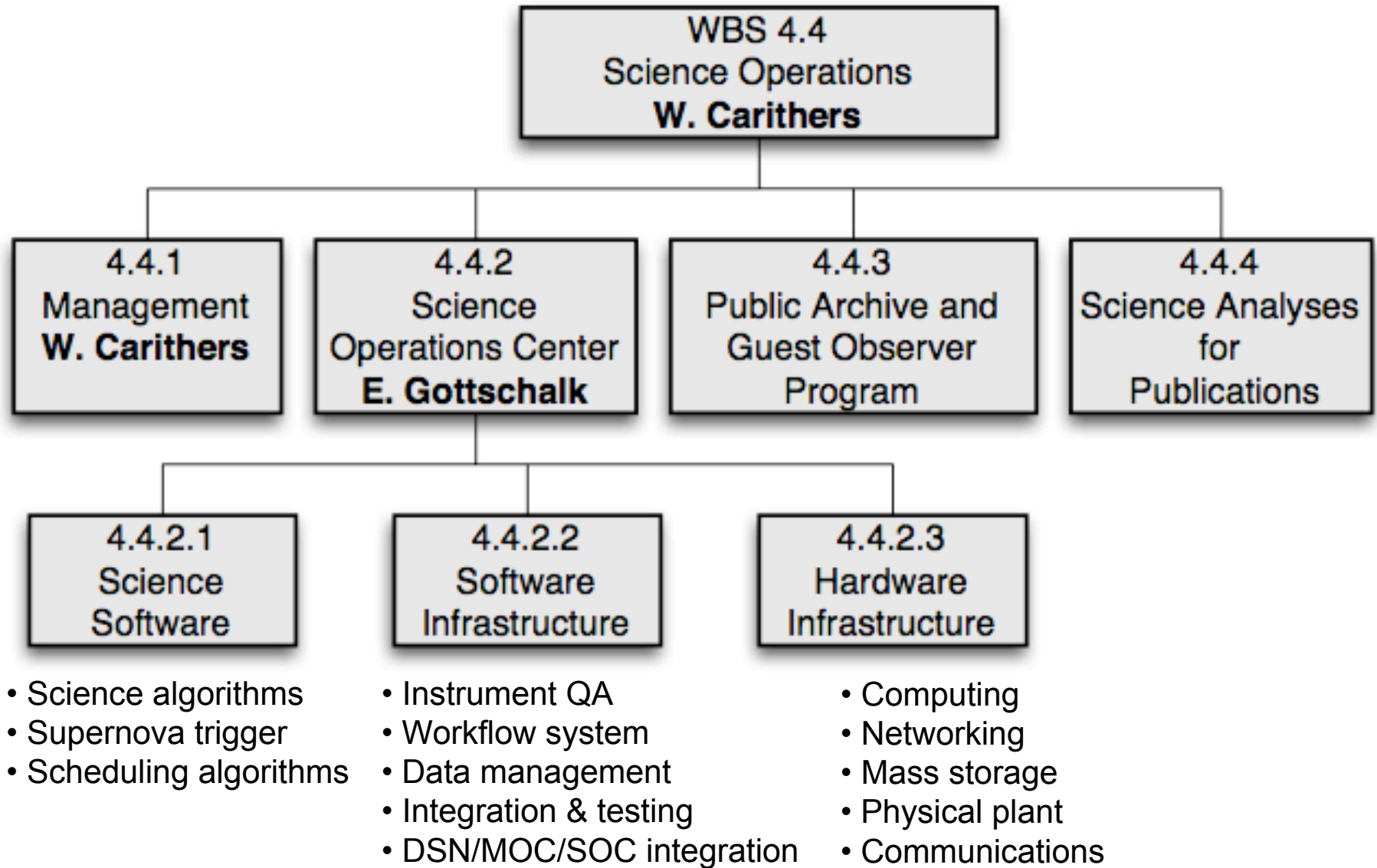


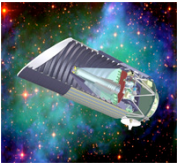
## Core Infrastructure (Data Reduction & Quality Assurance)



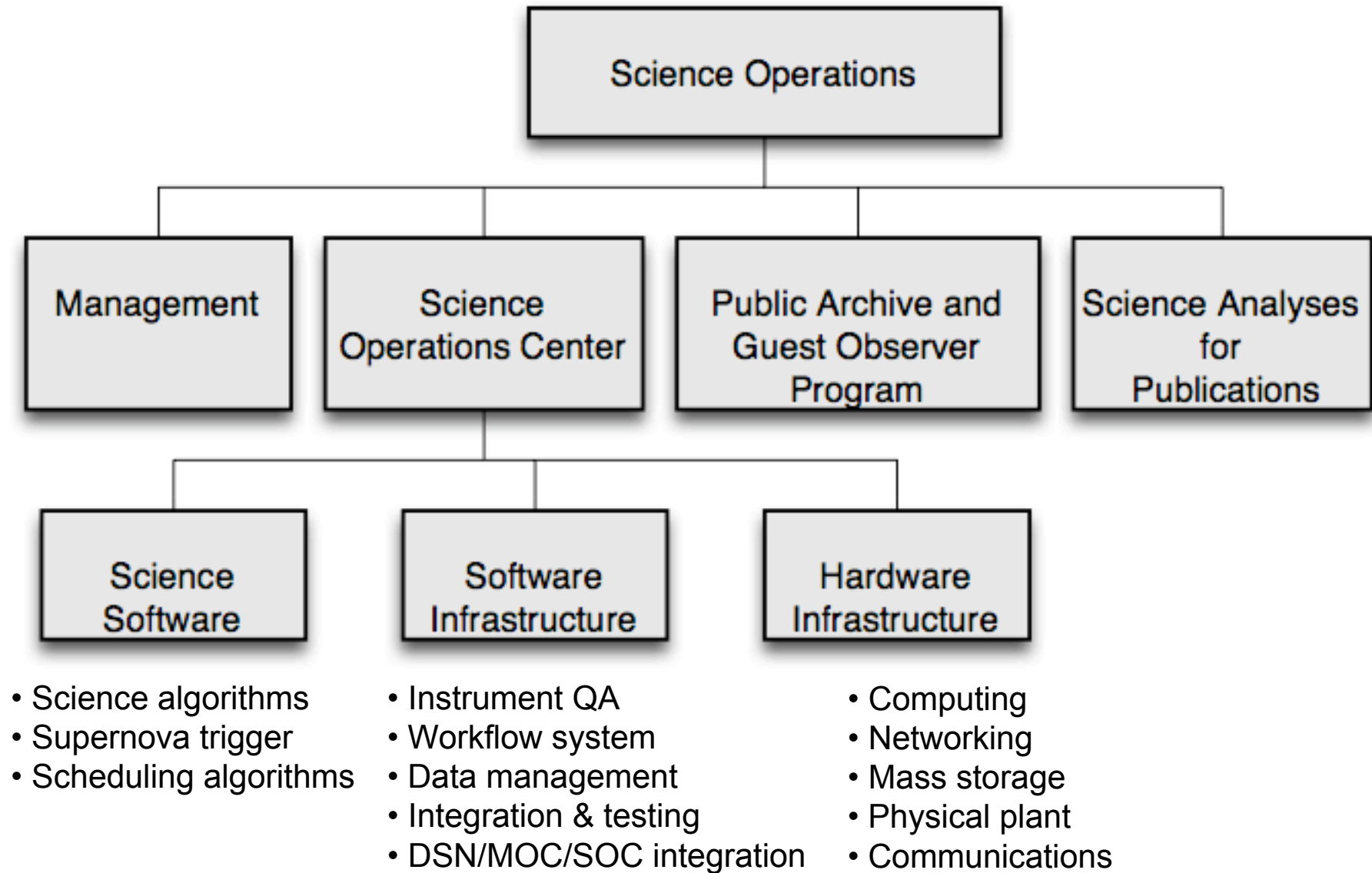


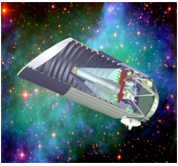
## SNAP Science Operations WBS



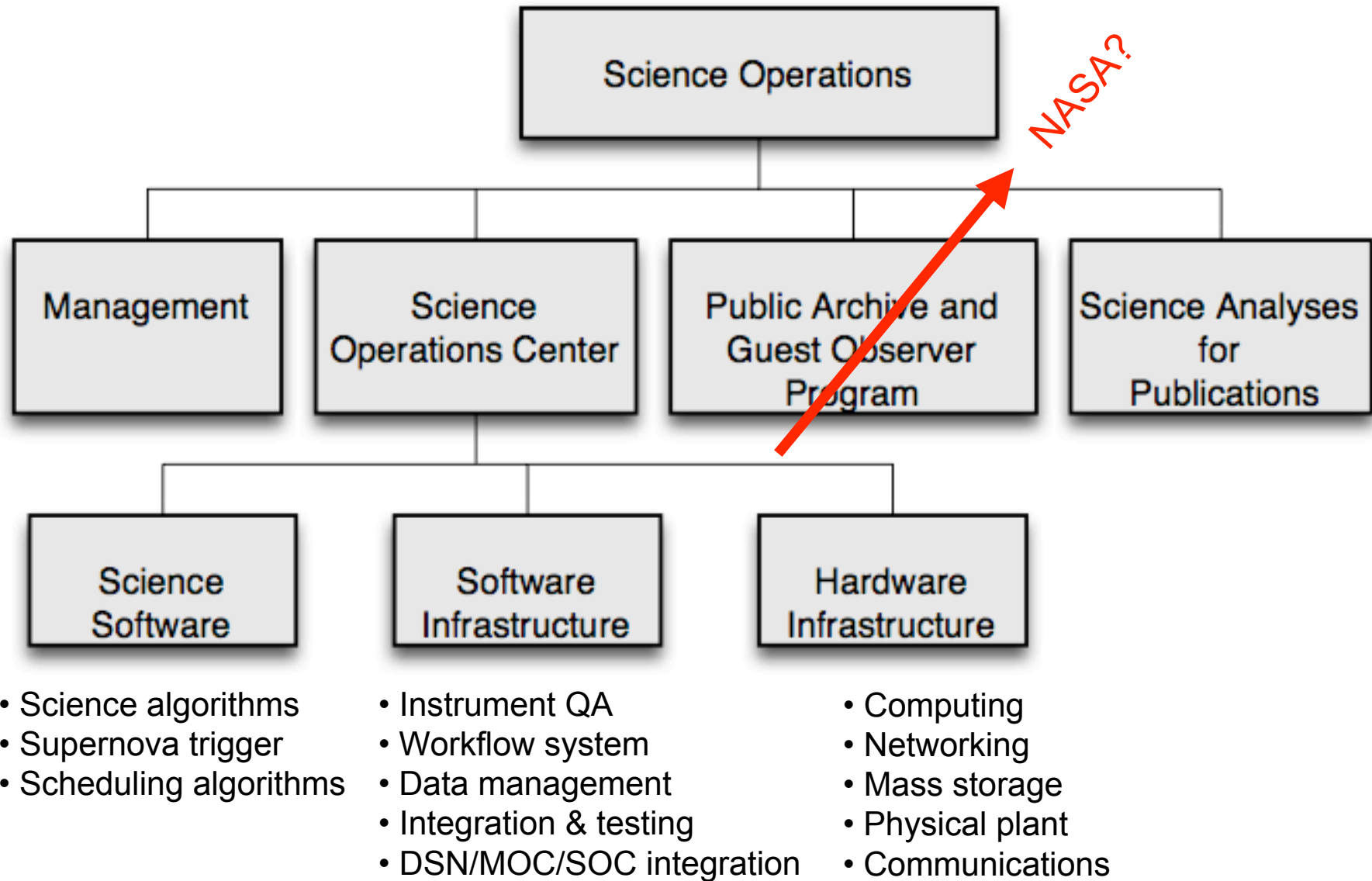


## Notional JDEM Science Operations WBS

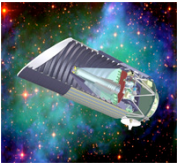




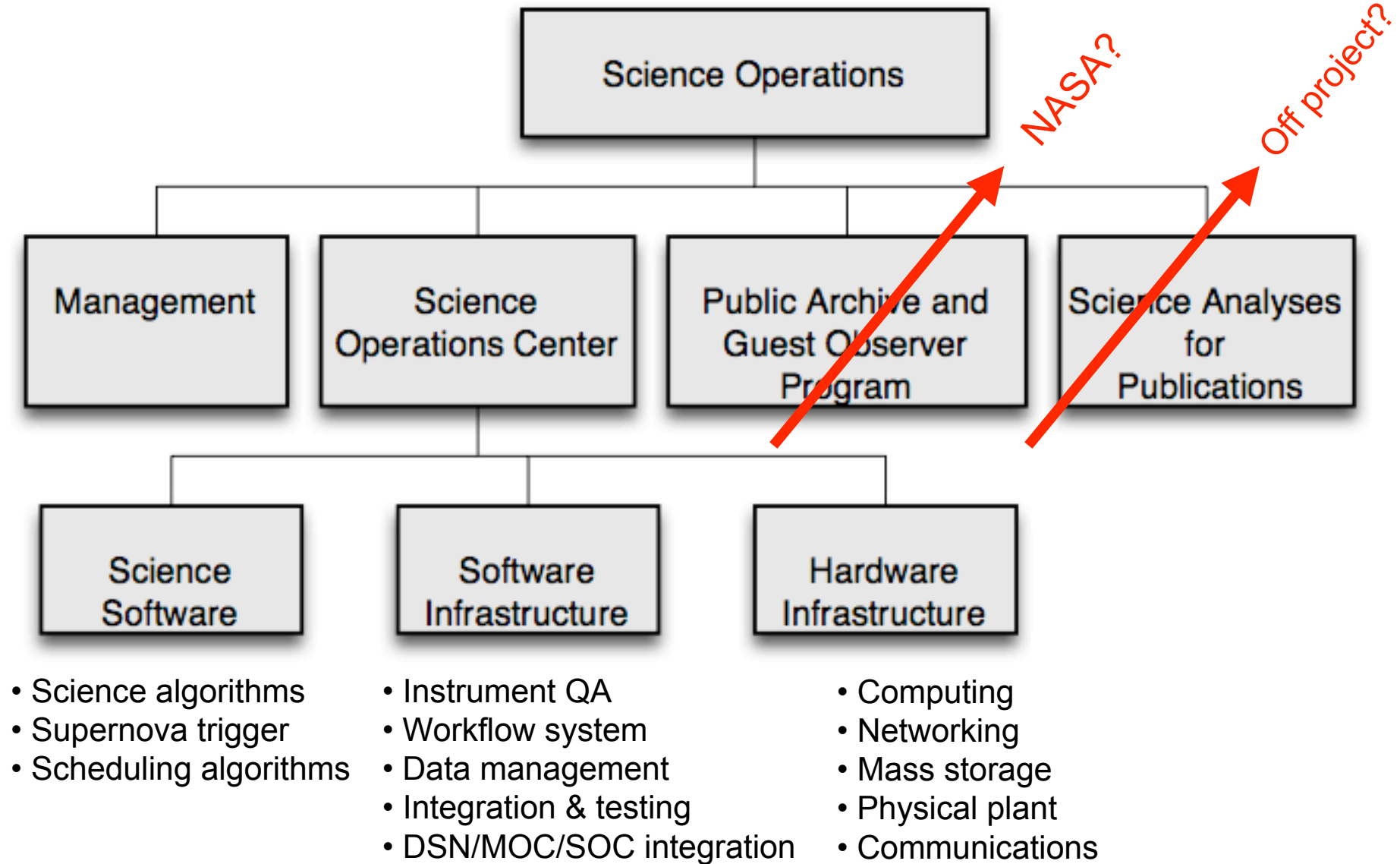
## Notional JDEM Science Operations WBS



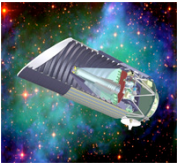




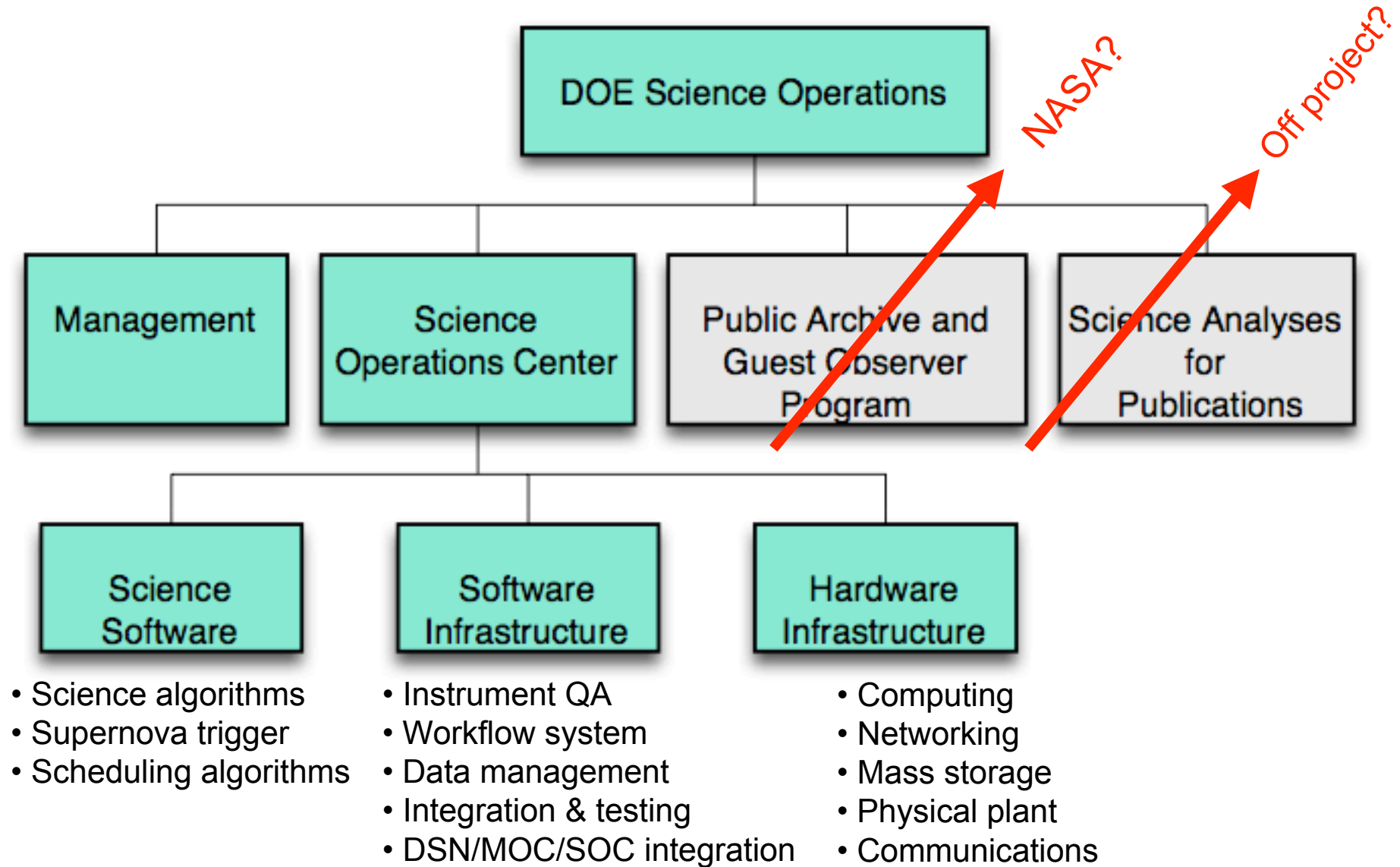
## Notional JDEM Science Operations WBS

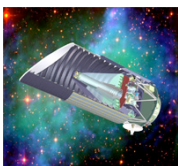




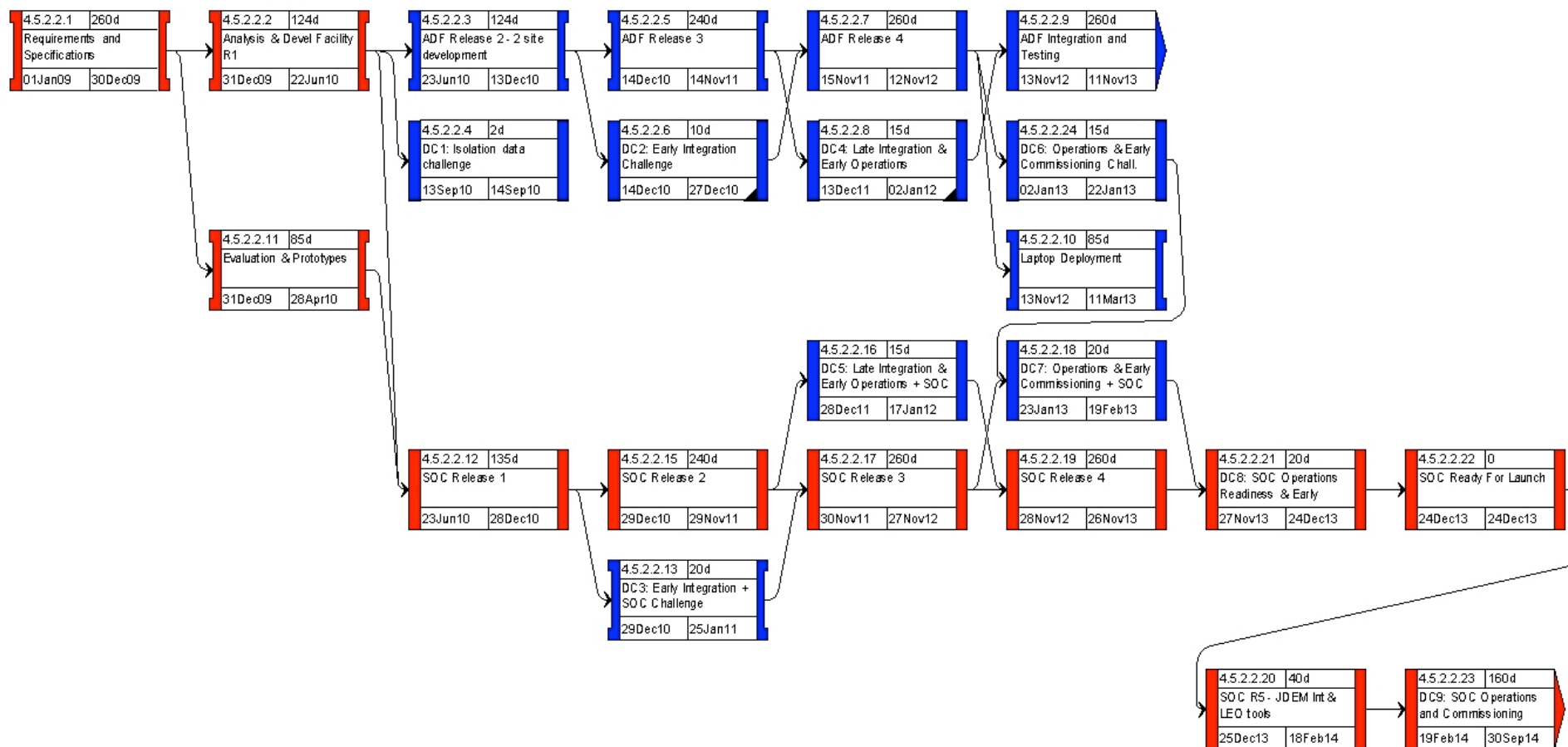


## Notional JDEM Science Operations WBS



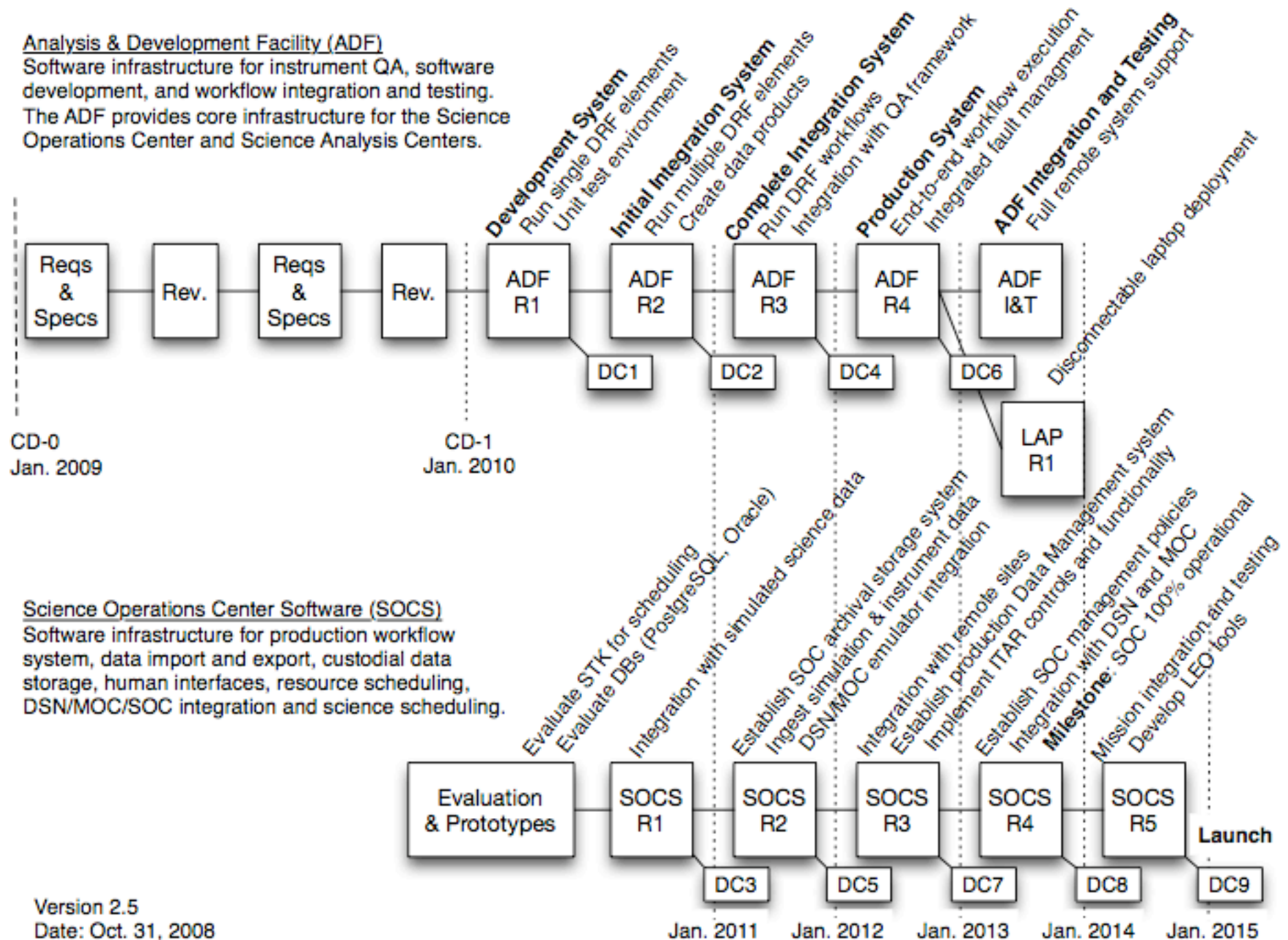


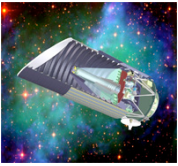
# WBS Network View of Software Infrastructure



### Analysis & Development Facility (ADF)

Software infrastructure for instrument QA, software development, and workflow integration and testing. The ADF provides core infrastructure for the Science Operations Center and Science Analysis Centers.

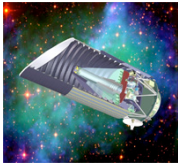




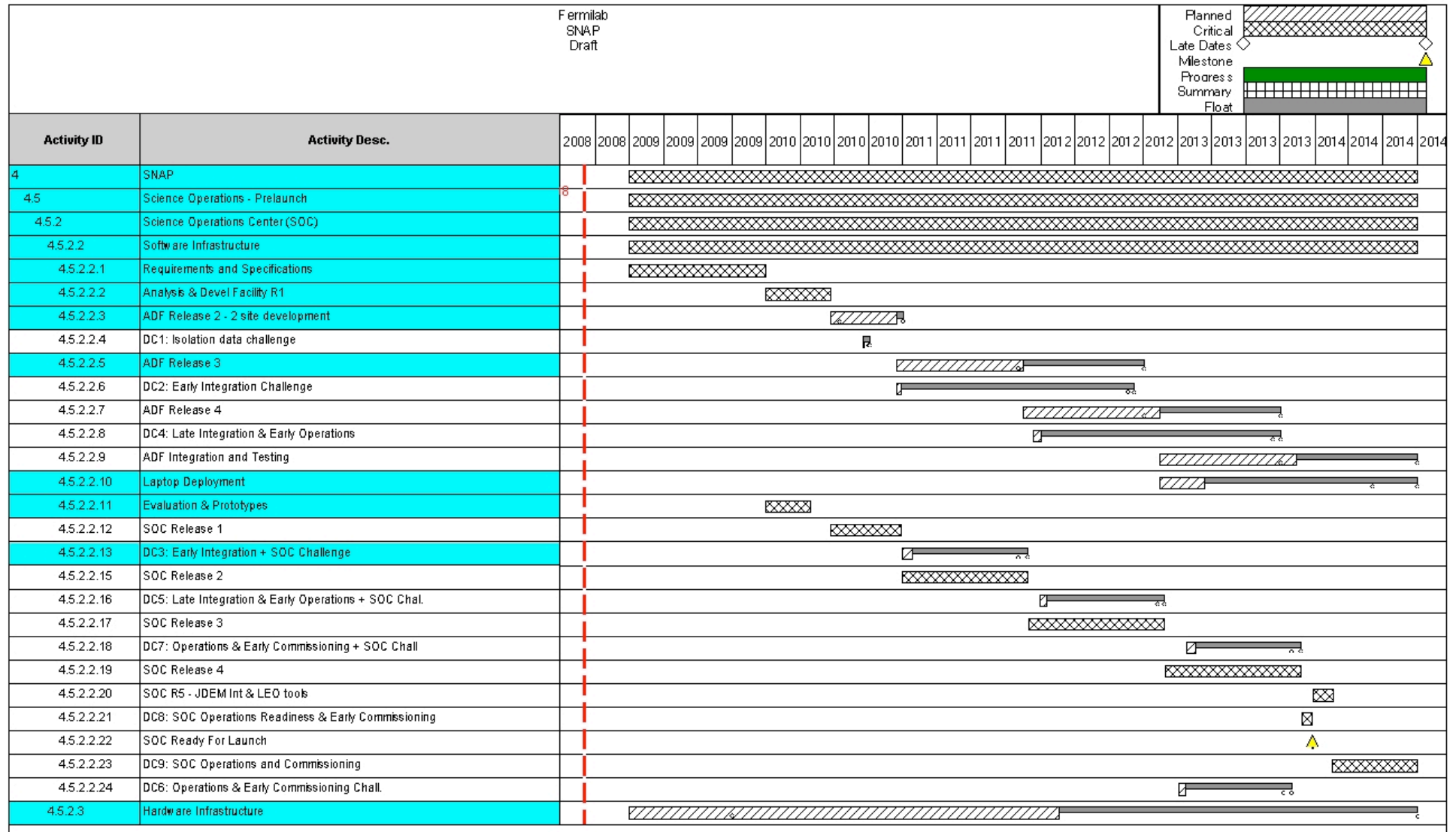
## Data Challenges

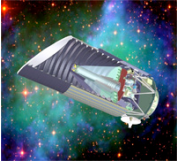
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- DC1 - Unit Testing
- DC2 - Early Integration
- DC3 - Early Integration with SOC
- DC4 - Late Integration and Early Operations
- DC5 - Late Integration and Early Operations with SOC
- DC6 - Operations and Early Commissioning
  - Basic component testing, testing interconnections between systems, system load testing, DB load and scalability testing, network throughput, storage throughput, pipeline testing, provenance store testing, end-to-end testing, hardware and software monitor testing, simulated calibration, multiple workflow management, and fault injection testing.
- DC7 - Operations and Early Commissioning with SOC
- DC8 - SOC Operations Readiness and Early Commissioning
- DC9 - SOC Operations and Commissioning
  - Includes all of DC6, and...
  - DSN to SOC throughput testing, SOC to remote ADF testing, SN trigger testing, MOC integration testing, reprocessing, ITAR testing, ORL generation testing, commissioning studies, and operations center staffing.



# Gantt Chart for Software Infrastructure

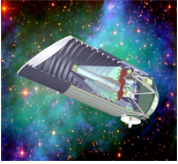




## Conclusion

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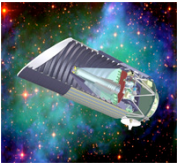
- We have developed a conceptual design for Science Operations that is applicable to JDEM.
- We will adapt our design to meet any new requirements for a JDEM Science Operations Center.
- Our design includes three software deployments:
  1. Analysis and Development Facility
    - Designed to support science software development
    - Provides support for instrument QA early in the schedule
    - Provides core infrastructure for the SOC and SACs
  2. Science Operations Center Software
    - Production data processing pipelines
    - Integration with NASA's DSN and MOC
  3. Laptop Deployment
    - Software development, instrument QA and science analysis



## Additional Slides

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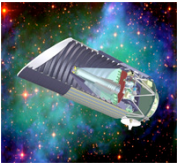


## Site Visits

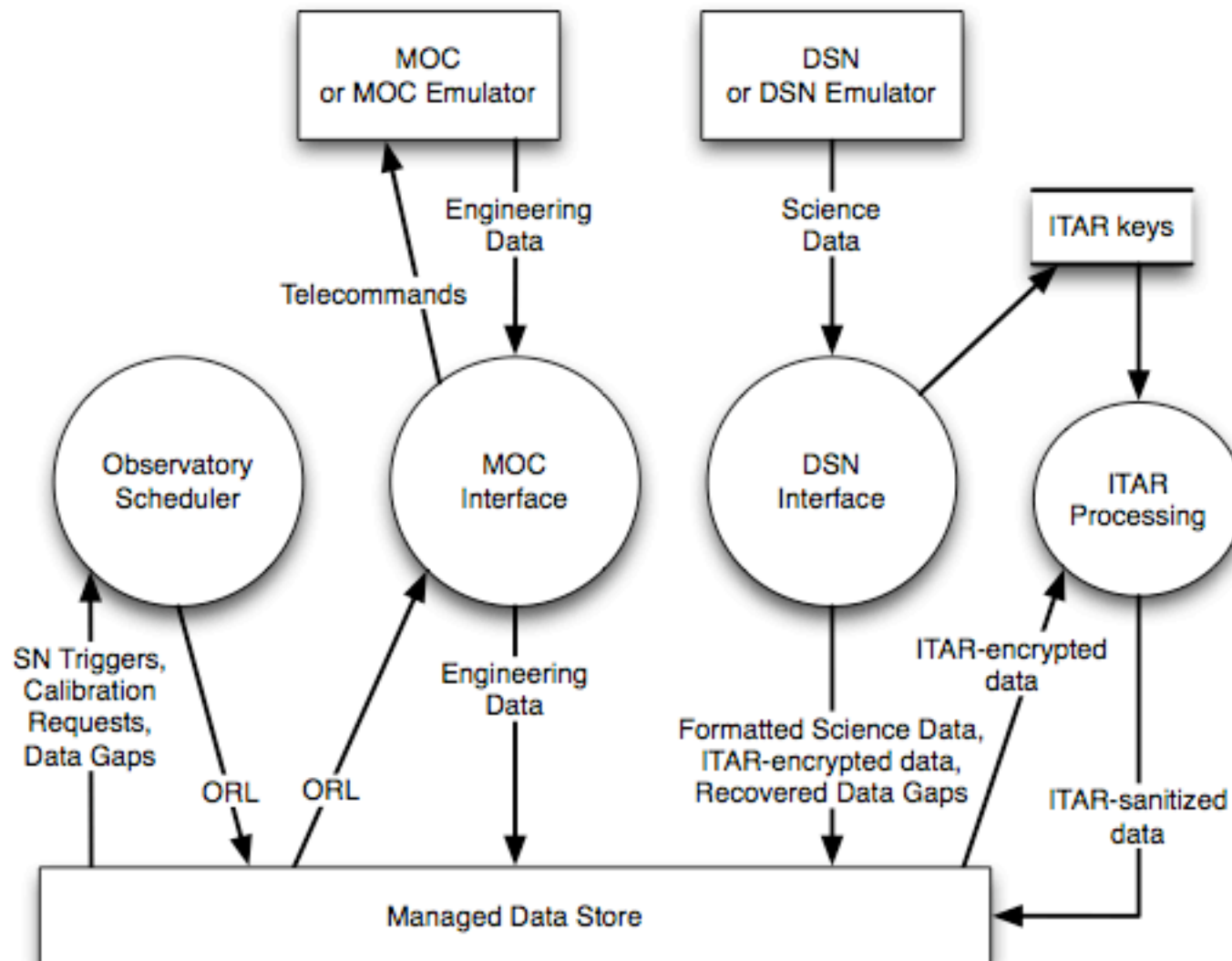
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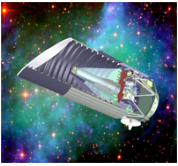
- Gemini Project remote control room – Hilo, HI **(Sept. 20, 2005)**
- Hubble Space Telescope Operations Center at STScI – Baltimore, MD **(Oct. 25, 2005)**
- European Space Operations Centre (ESOC) – Darmstadt, Germany **(Dec. 7, 2005)**
- Fermi Instrument Science Operations Center (ISOC)– Menlo Park, CA **(Aug. 20, 2008)**
- Fermi Mission Operations Center (MOC) at GSFC – Greenbelt, MD **(Sept. 24, 2008)**
- Advanced Composition Explorer (ACE) MOC – Greenbelt, MD **(Sept. 26, 2008)**
- Rossi X-Ray Timing Explorer (RXTE) MOC – Greenbelt, MD **(Sept. 26, 2008)**
- Rossi X-Ray Timing Explorer Science Ops Facility – Greenbelt, MD **(Sept. 26, 2008)**
- Wilkinson Microwave Anisotropy Probe (WMAP) – Greenbelt, MD **(Sept. 26, 2008)**
- Earth Observing Mission 1 (EO-1) MOC – Greenbelt, MD **(Sept. 26, 2008)**
- Solar Dynamic Observer (SDO) MOC – Greenbelt, MD **(Sept. 26, 2008)**
- HST Servicing Mission 4 Alternate Ops Area (AOA) – Greenbelt, MD **(Sept. 26, 2008)**
- NASA Communication Area – Greenbelt, MD **(Sept. 26, 2008)**
- Jet Propulsion Laboratory (JPL) – Pasadena, CA **(Nov. 5, 2008)**
- Spitzer Science Center at IPAC – Pasadena, CA **(Nov. 7, 2008)**
- 2 Micron All Sky Survey (2MASS) at IPAC – Pasadena, CA **(Nov. 7, 2008)**





## MOC and DSN Interfaces

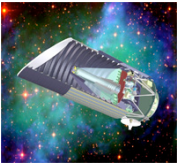




## Data Challenges 1 - 4

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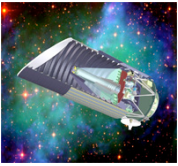
- **DC1 - Unit Testing**
  - Basic component testing (25%), testing interconnections between systems, system load testing (50%), DB load and scalability testing (50%), network throughput (25%), and storage throughput (25%).
- **DC2 - Early Integration**
  - Basic component testing (50%), testing interconnections between systems, system load testing (50%), DB load and scalability testing (100%), network throughput (50%), storage throughput (50%), pipeline testing (50%), and provenance store testing.
- **DC3 - Early Integration with SOC**
  - Basic component testing (50%), testing interconnections between systems, system load testing (50%), DB load and scalability testing (100%), network throughput (50%), storage throughput (50%), pipeline testing (50%), provenance store testing, and simulated science data (50%).
- **DC4 - Late Integration and Early Operations**
  - Basic component testing (75%), testing interconnections between systems, system load testing (75%), DB load and scalability testing (150%), network throughput (75%), storage throughput (75%), pipeline testing (75%), provenance store testing, initial end-to-end testing (50%), hardware and software monitoring testing, and simulated calibrations (25%).



## Data Challenges 5 - 6

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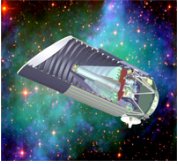
- **DC5 - Late Integration and Early Operations with SOC**
  - Basic component testing (75%), testing interconnections between systems, system load testing (75%), DB load and scalability testing (150%), network throughput (75%), storage throughput (75%), pipeline testing (75%), provenance store testing, initial end-to-end testing (50%), hardware and software monitoring testing, simulated calibrations (25%), DSN to SOC throughput testing, SOC to remote ADF testing, SN trigger testing (25%), and emulated MOC testing.
- **DC6 - Operations and Early Commissioning**
  - Basic component testing (100%), testing interconnections between systems, system load testing (100%), DB load and scalability testing (200%), network throughput (100%), storage throughput (100%), pipeline testing (100%), provenance store testing, end-to-end testing (75%), hardware and software monitor testing, simulated calibrations (50%), multiple workflow management, and fault injection testing.



## Data Challenges 7 - 8

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- **DC7 - Operations and Early Commissioning with SOC**
  - Basic component testing (100%), testing interconnections between systems, system load testing (100%), DB load and scalability testing (200%), network throughput (100%), storage throughput (100%), pipeline testing (100%), provenance store testing, end-to-end testing (75%), hardware and software monitor testing, simulated calibrations (50%), multiple workflow management, fault injection testing, DSN to SOC throughput testing, SOC to remote ADF testing, SN trigger testing (50%), emulated MOC testing, reprocessing (50%), ITAR testing, ORL generation testing, and operations center staffing.
- **DC8 - SOC Operations Readiness and Early Commissioning**
  - Basic component testing (100%), testing interconnections between systems, system load testing (100%), DB load and scalability testing (200%), network throughput (100%), storage throughput (100%), pipeline testing (100%), provenance store testing, end-to-end testing (100%), hardware and software monitor testing, simulated calibrations (100%), multiple workflow management, fault injection testing, DSN to SOC throughput testing, SOC to remote ADF testing, SN trigger testing (100%), emulated MOC testing, reprocessing (100%), ITAR testing, ORL generation testing, operations center staffing, and mock commissioning studies.



## Data Challenge 9

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- DC9 - SOC Operations and Commissioning
  - Basic component testing (100%), testing interconnections between systems, system load testing (100%), DB load and scalability testing (200%), network throughput (100%), storage throughput (100%), pipeline testing (100%), provenance store testing, end-to-end testing (100%), hardware and software monitor testing, simulated calibrations (100%), multiple workflow management, fault injection testing, DSN to SOC throughput testing, SOC to remote ADF testing, SN trigger testing (100%), MOC integration testing, reprocessing (100%), ITAR testing, ORL generation testing, operations center staffing, and commissioning studies.